

PHYTOTOXICOLOGY ASSESSMENT SURVEYS
CONDUCTED IN THE VICINITY OF
BURNSTEIN CASTINGS, CATHARINES STREET,
ST. CATHARINES, ONTARIO
MARCH THROUGH AUGUST, 1988

JULY 1989



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Jim Bradley
Minister

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PHYTOTOXICOLOGY ASSESSMENT SURVEYS CONDUCTED
IN THE VICINITY OF BURNSTEIN CASTINGS,
CATHARINE STREET, ST. CATHARINES -
MARCH THROUGH AUGUST, 1988

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Phytotoxicology Section
Air Resources Branch

ARB-176-88-Phyto

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Phytotoxicology Assessment Surveys Conducted in the
Vicinity of Burnstein Castings, Catharine Street, St. Catharines
- March through August, 1988.

During 1988, soil and vegetation collection programs were conducted by the Phytotoxicology Section in the vicinity of Burnstein Castings, Catharine Street, St. Catharines, at the request of Mr. R. Slattery, MOE, Welland. Burnstein Castings, formerly called Samco (1966 - 1970), has operated at the present location since 1966. The company leases the property from the city.

INITIAL SOIL COLLECTION PROGRAM - MARCH 1988

The initial soil sampling program was performed on March 3, 1988, shortly after a public meeting at which area residents expressed concern that emissions from the Burnstein Castings plant may be contaminating area properties. The area residents were primarily concerned about lead emissions.

On March 3, 1988, staff of the Phytotoxicology Section collected surface soil from nine sites; however, because of frozen soil conditions in March, only shallow soil cores to about a 2 cm depth could be collected at each site. The analytical results revealed that soil levels of copper were elevated (>100 ppm) at six sites in the immediate vicinity of Burnstein Castings, with soil levels of lead and other metals being well within a normal range when compared to the Phytotoxicology Section Upper Limit of Normal guidelines for urban surface soil (0-5 cm). The results of the March preliminary soil assessment survey have been previously reported (see ARB-085-88-Phyto).

FOLLOW-UP SURVEYS

Soil Collection - May 1988

Because none of the soil sites in March could be sampled to the standard sampling depth of 0-5 cm, the depth on which the Upper Limit of Normal guidelines are based, a follow-up soil collection program was performed on May 11, 1988. During the May survey, surface soil to the standard 5 cm depth, in addition to sub-soil (15-20 cm or 10-15 cm), was collected at the six locations (Sites 1, 3, 4, 5, 6 and 8) where soil copper levels were found to be elevated (>100 ppm) in March. The sites where both surface soil and sub-soil were sampled included the elementary school playfield (Site 1), the community center south yard (Site 5) and the boulevard just west of the seniors' residence (Site 4)(see attached Figure 1). Surface soil also was collected to a 5 cm depth at several new sites to the neighbouring north and west of Burnstein Castings, as well as at remote sites. In May, primarily front and/or back lawn areas on residential properties were sampled, with duplicate samples being collected at each site using an Oakfield soil sampler.

Maple Foliage Collection - August 1988

In order to assess the status of current, ongoing emissions from Burnstein Castings, maple foliage was sampled on August 23, 1988 at seven locations (Sites 1, 2, 3, 4, 5, 6 and 7) in the immediate vicinity of the plant as well as at five more remote locations (Sites 8, 9, 10, 11 and 12). As with soil, duplicate samples were collected at each site (see attached Figure 2). Sites 3 and 4 were adjacent to the open windows on the west side of the Burnstein Castings building and the foliage collected from these sites displayed a blackish surface deposit. Heavy rain was encountered during foliage sampling at Sites 11 and 12.

SUBMISSION OF SAMPLES FOR ANALYSIS

As in March, all samples were delivered to the Phytotoxicology Section for processing and were submitted, on a dry weight basis, to the Laboratory Services Branch, MOE, for analysis. The samples collected in May (soil) and August (foliage) were analyzed for the following 13 metal elements - beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), vanadium (V) and zinc (Zn).

EXPLANATION OF UPPER LIMIT OF NORMAL GUIDELINES

In this report, the soil and tree foliage results are compared with Phytotoxicology Section "Upper Limit of Normal" guidelines for urban areas. The Phytotoxicology Section Upper Limit of Normal (ULN) urban guidelines shown in the attached tables represent the expected maximum concentrations of the preceding metals in non-agricultural soil and foliage from urban areas of Ontario not subject to the direct influence of point sources of emissions. The ULN urban guidelines are based upon samples collected from centres of minimum 10,000 population. The ULNs were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. Assuming data are normally distributed, 99% of "urban background" samples will contain concentrations of elements lower than or equal to the ULNs. Thus, exceedances of the ULNs implicate an extraneous pollution source. It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above-normal concentrations. Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations below the guidelines would not normally be considered toxic. A brief review of world literature has shown that the guideline concentrations are generally within the respective ranges of urban background results reported by other investigators.

ANALYTICAL RESULTS

Soil Results - May 1988

In attached Tables 1a and 1b, the May soil results for sites closest to the Burnstein Castings company are compared to both the more remote data, which reflect natural background levels, and the Phytotoxicology Section ULN guidelines for urban surface soil (0- 5 cm). As in March, only copper was found to be abnormally elevated (>100 ppm) in surface soil (0-5 cm) in the immediate area of Burnstein Castings. The Cu levels found at Site 12 (840 ppm), to the northwest, and at Site 18 (1,000 ppm), to the north (see Figure 1), were several times higher than the 100 ppm ULN guideline for Cu in soil. The fact that soil copper levels were elevated in the immediate area of Burnstein Castings and were lower (range 28- 83 ppm) at more remote sites, implicates emissions from Burnstein Castings as the primary source of the Cu elevation in the surface soil.

Table 2 shows that soil sampling to the standard 5 cm depth in May resulted in generally lower soil Cu levels at the six locations (Sites 1, 3, 4, 5, 6 and 8) where markedly higher Cu levels were found in the shallow cores (0-2 cm) collected in March. The surface (0-5 cm) and sub-soil (10-15 cm) samples collected in May at these sites (with exception of Site 5) also revealed a pattern of higher Cu levels in the surface soil, further implicating the presence of an atmospheric source of Cu deposition in the area. Of the six sites where sub-soil was collected, only Site 5 (community centre) was found to display an opposite pattern and to have an elevated Cu level (>100 ppm) in the sub-soil. It is suspected that this reverse pattern resulted from soil excavation or other site disturbance activities during construction of the fairly new community center building.

None of the other soil analyses results from sites located closest to Burnstein Castings revealed any significant elevation or pattern of contamination relative to the corresponding results from more remote sites.

Significance of Elevated Soil Cu Levels

Upon reviewing the world literature, soil Cu levels above 300 ppm are considered by the Phytotoxicology Section to be potentially phytotoxic. Investigators in Ontario, Quebec, Holland and the U.S. have recommended and/or adopted soil clean-up (site decommissioning) guidelines for Cu ranging between 100 and 500 ppm.

As shown in Table 1a, six sites in May were found to have greater than 300 ppm Cu in the soil. To determine if vegetation at these sites is being negatively affected by the soil Cu levels, an in-depth bioassay study would have to be conducted.

As the soil results revealed a pattern of higher levels in the surface soil (0-5 cm), shallow rooted plants would be expected to have a greater potential for injury than deep rooted vegetation. Significant adverse affects to mature trees in the survey area would not be anticipated.

Foliage Results and Observations - August 1988

Copper, Molybdenum and Nickel Results

As shown in attached Table 3, foliar levels of Cu (52 & 25 ppm), Mo (2.1 & 2.8 ppm) and Ni (12 ppm), which were detected at Sites 3 and/or 4 to the immediate west of Burnstein Castings, were in excess of the respective Phytotoxicology Section ULN urban foliar guidelines (Cu-20 ppm; Mo-1.5 ppm; and Ni-5 ppm). The fact that the highest levels of Cu, Mo and Ni were detected at foliar sites displaying blackish

surface deposits and which were close to Burnstein's open west windows and that corresponding foliage results from more remote sites were all within a normal range, suggests that Burnstein Castings was the source of these metals during the 1988 growing season. However, as the higher foliar levels of Cu, Mo and Ni were confined to the immediate area of the company and were only moderately elevated compared to the ULN guidelines, it would appear that operations at the plant during 1988 resulted in only minor emissions of these metals. The fact that only copper was elevated at soil sites in the survey area would suggest that Burnstein Castings has, over the years, been a more significant source of copper than of the other metals. Moreover, on the basis that only moderately elevated foliar Cu levels were found during what was an unusually dry summer (May-August rainfall 22% lower than normal), it is concluded that historic emissions (as opposed to current emissions) from Burnstein Castings (and/or Samco) have been the major contributor to the elevated soil Cu levels found in the survey area.

The foliage with blackish surface deposition collected from the mature silver maples (Sites 3 and 4) next to Burnstein's open west windows also displayed some obvious injury - primarily brownish-black tip and/or marginal necrosis. However, the elevated Cu, Mo and Ni levels found in the unwashed foliage at these sites would not be expected to cause vegetation injury; hence, it is doubtful that Burnstein emissions were the primary cause. Marginal foliar injury is not uncommon on urban street trees in August, especially during a dry summer, and it is possible that the observed foliar injury was related to droughty soil conditions. Nonetheless, the injury aspect will be investigated more thoroughly in 1989.

Chromium, Iron, Lead, Manganese and Zinc Results

Slightly higher foliar levels of Cr, Fe, Pb, Mn and Zn also were detected at some sites in the immediate area of Burnstein Castings

compared to more distant sites, suggesting that the company also is a source of these elements (Table 3). However, as the higher levels were only very marginally elevated compared to those at more remote locations and as none were in excess of the respective ULN guidelines, it would appear that the Burnstein Castings plant is not a significant source of these metals. The soil results would further support this finding.

SUMMARY

In summary, the March and May 1988 soil results revealed that only Cu was abnormally elevated in surface soil in the immediate area of Burnstein Castings. At several sites, the soil Cu level was considered to be potentially phytotoxic. The August 1988 maple foliage data confirmed that this company is an emission source of Cu and of several other metals. However, because the foliar data indicated that current operations at Burnstein Castings represent only a minor emission source of metals, including Cu, it is concluded that historic emissions from Burnstein Castings (and/or Samco) have been the major contributor to the elevated soil Cu levels found in the survey area.

The fact that only Cu was elevated at soil sites in the survey area confirms that emissions of all other metals, including Pb, over the years, have been very minor.

RECOMMENDATIONS

In light of the preceding results, it is recommended that the soil sampling program in the vicinity of Burnstein Castings be expanded in 1989 to more precisely determine the area with potential for phytotoxic effects. It is also recommended that the foliage sampling

program be repeated in 1989. The Phytotoxicology Section also is prepared to perform a greenhouse bioassay study to determine if vegetation in the survey area is being adversely affected by the elevated soil Cu levels. It is recommended that this report be forwarded to the MOE Hazardous Contaminants Co-ordination Branch and to the Medical Officer of Health in St. Catharines for information/advice concerning human health aspects.

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TABLE 1a: Soil Concentrations of Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron and Lead Detected in the Vicinity of Burnstein Castings - May 11, 1988.

Site NO. (See Fig. 1)	Site Description	Soil Depth (cm)	*Average Soil Concentration - ppm, dry weight						
			Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead
			Sites Closest to Burnstein Castings						
1a	School Playfield - E Limit	0-5	0.6	0.4	13	6	230	11,000	59
		15-20	<0.5	0.5	12	6	42	11,000	49
1b	" " - N Limit	0-5	0.6	0.5	14	6	135	11,500	40
3	Public Park - Boulevard	0-5	0.8	0.8	20	7	98	14,500	105
		15-20	0.7	0.6	16	7	27	16,000	49
4	Seniors' Residence - W Yard	0-5	<0.5	0.3	12	5	54	11,000	17
	- Boulevard	0-5	0.8	0.6	21	7	225	15,000	88
		15-20	0.8	0.5	18	9	33	18,000	18
5	Community Centre - S Yard	0-5	0.8	0.5	18	8	185	14,500	66
		10-15	0.8	1.0	24	9	520	20,000	210
6	Russell Ave. - Boulevard	0-5	0.6	0.6	16	6	104	12,500	58
		15-20	0.8	0.5	16	8	32	15,000	31
8	George St. - Backyard	0-5	0.8	0.7	20	8	55	14,000	115
	- Boulevard	0-5	0.6	0.8	20	7	365	14,000	145
		15-20	0.8	0.5	16	7	34	14,000	48
10	George St. - Front Yard	0-5	0.7	0.9	23	8	175	15,000	170
	- Backyard	0-5	0.7	0.9	19	8	41	15,000	100
11	George St. - Garden	0-15	0.7	0.7	18	8	47	13,000	115
12	George St. - Front Yard	0-5	0.7	0.6	19	7	840	14,500	205
18	Russell Ave. - Front Yard	0-5	0.7	1.2	32	7	1,000	14,000	250
	- Backyard	0-5	0.7	1.7	23	8	373	14,500	190
19	Russell Ave. - Front Yard	0-5	0.6	0.9	22	7	640	14,000	190
	- Backyard	0-5	0.6	0.7	19	7	215	13,500	160
20	Russell Ave. - Front Yard	0-5	0.7	0.9	23	7	695	14,000	230
	- Backyard	0-5	<0.5	1.0	20	7	260	13,000	120
			Sites More Remote						
1c	School Property - Front Yard	0-5	0.6	0.5	17	7	28	14,500	30
13	George St. - Front Yard	0-5	0.6	1.0	40	7	45	13,000	305
	- Backyard	0-5	<0.5	1.0	51	7	45	12,500	170
14	George St. - Front Yard	0-5	0.6	0.8	20	8	47	13,500	255
15	Pleasant Ave. - Front Yard	0-5	0.7	0.8	27	8	83	16,000	89
	- Backyard	0-5	<0.5	0.5	16	6	34	11,000	48
17	Russell Ave. - Front Yard	0-5	0.6	1.0	33	7	42	14,500	130
	- Backyard	0-5	0.6	0.6	19	7	34	14,000	95
21	Russell Ave. - Front Yard	0-5	0.8	0.6	17	7	58	11,500	69
	- Backyard	0-5	0.6	0.4	15	6	48	11,500	53
22	Colbey St. - Front Yard	0-5	0.6	0.7	18	7	62	15,000	94
23	Russell Ave. - Front Yard	0-5	0.6	0.8	21	7	36	15,000	225
24	Catharine St. - Boulevard	0-5	<0.5	0.9	26	6	38	12,000	160
			Phytotoxicology Section Soil Guidelines						
**upper Limit of Normal Guidelines			-	4	50	25	100	35,000	500

*Average of duplicate sample results

**Phytotoxicology Section Upper Limit of Normal guidelines for urban surface soil (0-5 cm)

NOTE: Results underlined exceed the guideline.

TABLE 1b: Soil Concentrations of Magnesium, Manganese, Molybdenum, Nickel, Vanadium and Zinc Detected in the Vicinity of Burnstein Castings - May 11, 1988.

Site No. (See Fig. 1)	Site Description	Soil Depth (cm)	*Average Soil Concentration - ppm, dry weight					
			Magnesium	Manganese	Molybdenum	Nickel	Vanadium	Zinc
			Sites Closest to Burnstein Castings					
1a	School Playfield - E Limit	0-5	2,000	220	0.4	10	20	87
		15-20	1,800	240	<0.2	10	20	61
1b	" " - N Limit	0-5	3,350	290	0.4	10	20	130
3	Public Park - Boulevard	0-5	5,150	375	0.4	17	26	130
		15-20	2,700	500.	0.3	10	27	57
4	Seniors' Residence- W. Yard	0-5	3,500	430	<0.2	8	18	30
	- Boulevard	0-5	5,350	395	0.3	17	24	85
		15-20	2,500	720	<0.2	13	28	34
5	Community Centre - S. Yard	0-5	3,650	290	0.4	14	25	69
		10-15	4,800	440	0.5	18	28	180
6	Russell Ave. - Boulevard	0-5	5,800	420	<0.2	12	20	84
		15-20	3,000	380	0.4	10	24	60
8	George St. - Backyard	0-5	2,450	320	<0.2	13	27	145
	- Boulevard	0-5	6,800	410	<0.2	18	25	165
		15-20	2,900	400	<0.2	10	26	53
10	George St. - Front Yard	0-5	2,500	355	0.5	16	28	180
	- Backyard	0-5	3,300	315	<0.2	12	27	140
11	George St. - Garden	0-15	2,550	275	<0.2	12	24	170
12	George St. - Front Yard	0-5	2,600	350	0.4	20	26	195
18	Russell Ave. - Front Yard	0-5	5,150	375	0.9	22	24	260
	- Backyard	0-5	3,100	360	0.8	18	25	240
19	Russell Ave. - Front Yard	0-5	4,200	320	0.6	19	25	270
	- Backyard	0-5	2,300	270	0.5	14	27	195
20	Russell Ave. - Front Yard	0-5	5,000	365	0.8	20	24	240
	- Backyard	0-5	1,800	255	0.7	12	26	175
			Sites More Remote					
1c	School Property - Front Yard	0-5	3,100	315	0.4	10	27	54
13	George St. - Front Yard	0-5	1,900	345	<0.2	12	24	210
	- Backyard	0-5	1,650	270	0.4	12	25	195
14	George St. - Front Yard	0-5	4,000	530	0.4	14	23	155
15	Pleasant Ave. - Front Yard	0-5	3,250	430	0.8	14	27	104
	- Backyard	0-5	1,700	240	0.6	9	22	66
17	Russell Ave. - Front Yard	0-5	2,900	365	0.5	13	28	104
	- Backyard	0-5	2,050	320	0.3	11	27	105
21	Russell Ave. - Front Yard	0-5	2,300	360	1.0	9	23	130
	- Backyard	0-5	1,800	260	0.5	9	22	92
22	Colbey St. - Front Yard	0-5	2,050	300	0.3	12	29	110
23	Russell Ave. - Front Yard	0-5	7,950	480	0.3	13	27	120
24	Catharine St. - Boulevard	0-5	10,750	475	0.4	11	22	120
			Phytotoxicology Section Soil Guidelines					
**Upper Limit of Normal guidelines			10,000 ^r	700	3	60	70	500

*Average of duplicate sample results

**Phytotoxicology Section Upper Limit of Normal guidelines for urban surface soil (0-5 cm)

r - Rural guideline - no urban guideline has been established by the Phytotoxicology Section.

TABLE 2: Comparison of Soil Copper Concentrations Detected at Corresponding Soil Sites Sampled in March and May 1988.

Site No. (See Fig. 1)	Site Description	*Average Soil Concentration (ppm, dry weight basis)	
		March 1988 (0-2cm depth)**	May 1988 (0-5 cm depth)**
1a	School - E Limit	460	230
1b	" - N Limit	140	135
3	Park - Boulevard	125	98
4	Seniors' Res. - W. Yard - Boulevard	220 705	54 225
5	Community Centre - S. Yard	985	185
6	Russell Ave. - Boulevard	295	104
8	George St. - Boulevard	655	365
Phytotoxicology Section Upper Limit of Normal urban Cu guideline for surface soil (0 - 5 cm)		100	

*Based on duplicate sample results.

**Depth to which soil was collected. The Upper Limit of Normal guideline is based on a 5 cm sampling depth.

TABLE 3: Metal Concentrations Detected in Maple Foliage Collected in the Vicinity of Burnstein Castings - August 23, 1988.

Site No. (See Fig. 2)	*Average Concentration in Foliage - parts per million, dry weight												
	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Vanadium	Zinc
					<u>Sites Closest to Burnstein Castings</u>								
1	<0.1	<0.1	3	0.3	13	275	4	2,850	118	0.6	2	<0.5	31
2	<0.1	<0.1	2	<0.2	10	195	2	3,500	44	0.5	1	<0.5	36
3 ^a	<0.1	<0.1	7	<0.2	<u>52</u>	620	15	2,350	36	<u>2.1</u>	<u>12</u>	<0.5	79
4 ^a	<0.1	0.1	3	0.3	<u>25</u>	315	5	2,350	35	<u>2.8</u>	<u>4</u>	<0.5	72
5	<0.1	<0.1	2	<0.2	20	455	7	2,300	58	0.6	2	<0.5	40
6	<0.1	<0.1	2	<0.2	14	365	4	2,100	45	0.5	1	<0.5	20
7	<0.1	<0.1	3	<0.2	17	415	7	3,150	50	0.8	3	<0.5	49
					<u>Sites More Remote</u>								
8	<0.1	<0.1	1	<0.2	6	160	3	2,050	18	0.3	<0.5	<0.5	18
9	<0.1	<0.1	2	<0.2	11	185	3	3,050	65	0.7	1	<0.5	34
10	<0.1	<0.1	1	<0.2	4	180	2	2,350	36	0.2	<0.5	<0.5	29
11	<0.1	<0.1	2	<0.2	10	155	2	2,600	36	0.3	1	<0.5	32
12	<0.1	0.2	2	0.3	7	180	2	2,900	32	0.3	1	<0.5	39
					<u>Phytotoxicology Section Guidelines</u>								
ULN**	-	3	8	2	20	1,000	60	7,000	-	1.5	7	5	250

a Site adjacent to open windows on W side of Burnstein building.

*Average of duplicate sample results

**Phytotoxicology Section Upper Limit of Normal guidelines for urban tree foliage (results underlined exceed guideline).

Figure 1: Approximate Location of Soil Sites Sampled in the Vicinity of
Burnstein Castings, St Catharines - May 11, 1988.

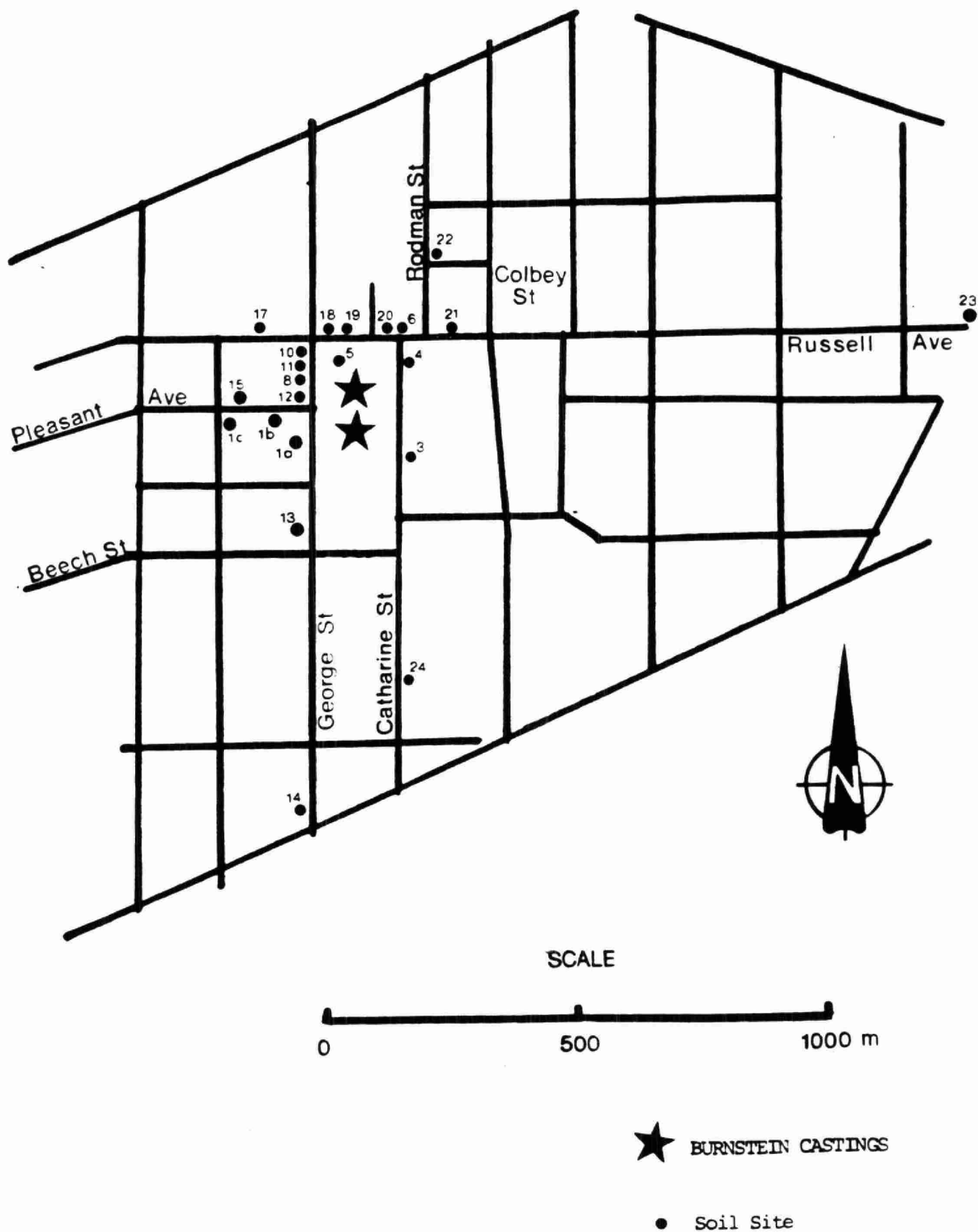
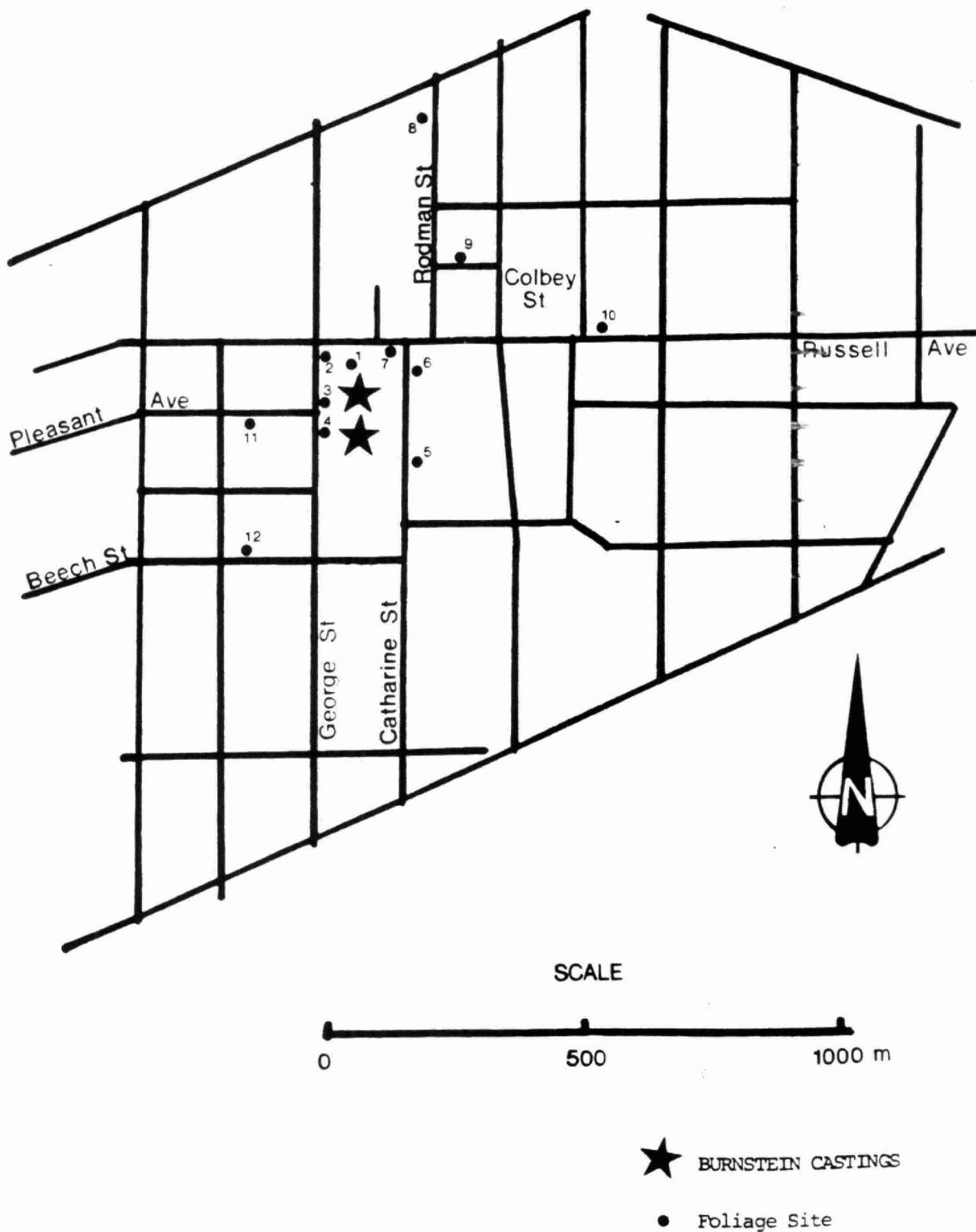


Figure 2: Approximate Location of Maple Foliage Sites Sampled in the Vicinity of Burnstein Castings, St Catharines - August 23, 1988.





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